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FTR Fuel Burnup: A REBUS-2, 2DB Comparison Study

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ABSTRACT

Using a typical FTR fuel cycle burn step problem, a comparison is made of the quantities predicted by the Westinghouse 2DB and ANL REBUS-2 fuel management codes. The quantities considered for comparison are power fractions and shifts, burnup, and EØC fuel inventory. These data are given for 14 sample regions. Excellent agreement was observed for all quantities, particularly the EØC atom densities.

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Using a typical FTR fuel cycle burn step problem, a comparison is made of the quantities predicted by the Westinghouse 2DB and ANL REBUS-2 fuel management codes. The quantities considered for comparison are power fractions and shifts, burnup, and EOC fuel inventory. These data are given for 14 sample regions. Excellent agreement was observed for all quantities, particularly the EOC atom densities.

I. INTRODUCTION

As a result of an RRD-sponsored Fuel Management Code Meeting held at Argonne National Laboratory (October 5-6, 1972), a commitment was made to execute a reference FTR fuel management problem selected by WARD, using both the ANL REBUS-2 and WARD 2DB codes. The primary purpose of this exercise was to provide an intercomparison of the WARD and ANL computational capabilities and to check the suitability of the REBUS-2 code for use in an FTR calculation.

The specific problem selected by WARD was the fuel burnup for the fourth cycle which is a typical FTR equilibrium cycle. Additionally, it was decided the problem comparison should be done using the same FTR 21 group cross section set utilized by WARD. The 21-group cross section set used by WARD in these calculations was transmitted to ANL in October 1973. Since these cross section data were supplied on punched cards in a unique format they were first converted to the CCCC (Committee on Computer Code Coordination) format of ISØTXS which was subsequently translated to the ARC System XS.ISØ format.

The following section describes the details of the cycle 4 burnup problem as determined by an examination of the 2DB computer output supplied by WARD. The specific numerical results obtained are presented in Section III and discussed in Section IV.

II. PROBLEM DEFINITION

The basic problem to be executed for comparison is a 94.262-day irradiation of an FTR two-dimensional hexagonal mesh core mockup using the 21-neutron energy group FTR cross section set provided by WARD. The core layout is shown in Fig. 1 which indicates the principal components and areas. Specifically, these are the inner and outer core areas, the four closed loops, the inner and outer control, the two material test regions, the peripheral control, the ring 7 reflector, and the ring 8 and 9 reflector. The remaining hexes of ring 9, not drawn in the map, are filled with sodium. These 241 hexes have been assigned to 109 different

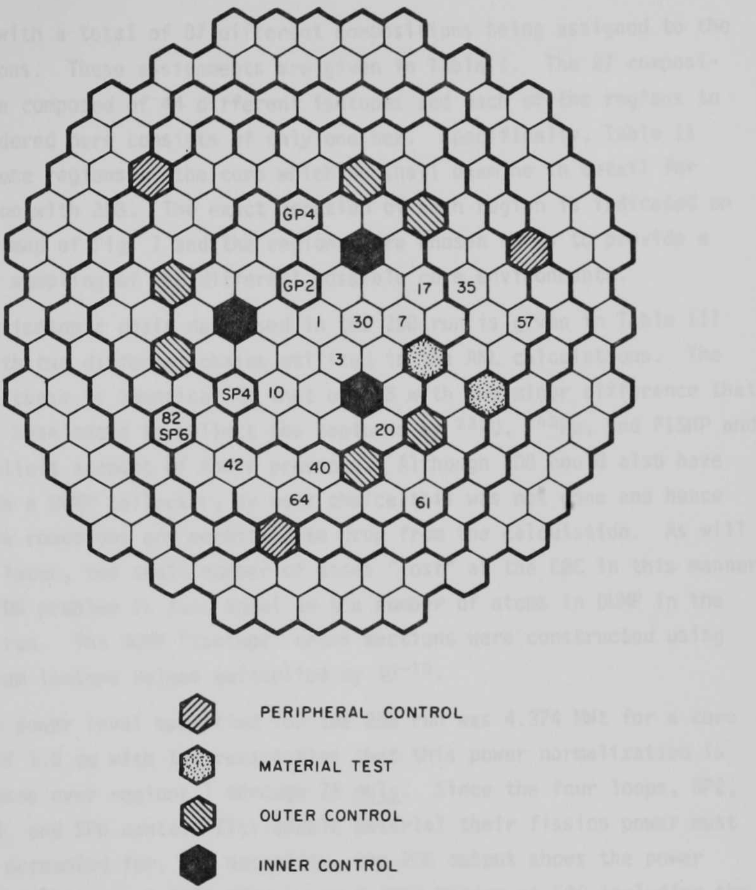

Fig. 1. Core map for reference FTR fuel management problem.

regions with a total of 87 different compositions being assigned to the 109 regions. These assignments are given in Table I. The 87 compositions are composed of 44 different isotopes and each of the regions to be considered here consists of only one hex. Specifically, Table II lists those regions of the core which we shall examine in detail for comparison with 2DB. The exact location of each region is indicated on the core map of Fig. 1 and the regions were chosen so as to provide a complete sampling of the different possible core environments.

The isotopic chain data used in the 2DB run is given in Table III along with two different chains utilized in the ANL calculations. The first of these is identical to that of 2DB with the minor difference that DUMP has been added to collect the captures by ^{235}U, ^{242}Pu, and FISHP and take explicit account of their presence. Although 2DB could also have used such a DUMP collector, by user choice this was not done and hence the above reactions are permitted to drop from the calculation. As will be seen later, the small number of atoms "lost" at the EØC in this manner in the 2DB problem is just equal to the number of atoms in DUMP in the REBUS-2 run. The DUMP "isotope" cross sections were constructed using the sodium isotope values multiplied by 10^{-10}.

The power level specified for the 2DB run was 4.374 MWt for a core height of 1.0 cm with the restriction that this power normalization is to be taken over regions 1 through 76 <u>only</u>. Since the four loops, GP2, GP4, SP4, and SP6 contain fissionable material their fission power must also be accounted for. In actuality, the 2DB output shows the power attained at BØC was 4.4091 MWt/cm and 4.4083 MWt/cm at EØC including the four test loops. Thus the average power over the cycle was 4.4087 MWt/cm. This is the power level used in the ANL calculation.

As an integral feature of the 2DB code, the 94.262-day burn period is divided into 10 equal subintervals. Using the original flux computed for BØC the code simply renormalizes this flux to the desired power at the end of each subinterval. The REBUS-2 calculation was performed in a like manner. A BØC explicit neutronics solution yielded the initial fluxes for t = 0. These fluxes were then renormalized at each subsequent subinterval to achieve the desired power of 4.4087 MWt/cm except that at EØC (t =

regions with a total of 87 different compositions being assigned to the 109 regions. These assignments are given in Table I. The 87 compositions are composed of 49 different isotopes and each of the regions to be considered here consists of only one hex. Specifically, Table II lists those regions of the core which we shall examine in detail for comparison with 2DB. The exact location of each region is indicated on the core map of Fig. 1 and the regions were chosen so as to provide a complete sampling of the different possible core environments.

The isotopic chain data used in the 2DB run is given in Table III along with two different chains utilized in the RML calculations. The first of these is identical to that of 2DB with the minor difference that DUMP has been added to collect the captures by ^{233}U, ^{242}Pu, and FISUM and take explicit account of their presence. Although 2DB could also have used such a DUMP collector, by user choice this was not done and hence the above reactions are permitted to drop from the calculation. As will be seen later, the small number of atoms "lost" at the EOC in this manner in the 2DB problem is just equal to the number of atoms in DUMP in the NEBUS-2 run. The DUMP "isotope" cross sections were constructed using the sodium isotope values multiplied by 10^{-15}.

The power level specified for the 2DB run was 6.374 MWt for a core height of 1.0 cm with the restriction that this power normalization is to be taken over regions 1 through 75 only. Since the four loops, GP2, GP4, SP4, and SP8 contain fissionable material their fission power must also be accounted for. In actuality, the 2DB output shows the power attained at BOC was 4.4091 MWt/cm and 4.4083 MWt/cm at EOC including the four test loops. Thus the average power over the cycle was 4.4087 MWt/cm. This is the power level used in the RML calculation.

As an internal feature of the 2DB code, the 94 202-day burn period is divided into 10 equal-subintervals. Using the original flux computed for BOC the code simply renormalizes this flux to the desired power at the end of each subinterval. The NEBUS-2 calculation was performed in a like manner. A BOC explicit neutronics solution yielded the initial fluxes for t = 0. These fluxes were then renormalized at each subsequent subinterval to achieve the desired power of 4.4087 MWt/cm except that at EOC (t =

TABLE I. Composition Assignments for FTR Test Problem

Composition Number	Region Assignment	Description
44 to 73	1 to 30	inner core fuel
74 to 119	31 to 76	outer core fuel
120	79	"fuel" for loop GP2
121	80	"fuel" for loop GP4
122	81	"fuel" for loop SP4
123	82	"fuel" for loop SP6
124	83, 84, 85	inner control channel
127	86 to 91	outer control rods
128	77, 78	material test loops
129	92 to 95 97 to 99 102 to 105 107	reflector, ring 7
130	108, 109	reflector, ring 8 and portion of ring 9
131	100	Na background, remainder of ring 9
132	96, 106, 101	peripheral control

TABLE II. FTR Regions Used for Comparison

Region Number	=	HEX Number*	Location
1		1	central hex, ring 1
3		3	inner core, ring 2; next to inner control rod
30		30	inner core, ring 2
7		7	inner core, ring 3; next to material test loop
10		10	inner core, ring 3; next to loop SP4
17		17	inner core, ring 3
20		20	inner core, ring 4, between two control rods
35		35	outer core, ring 5
40		40	outer core, ring 5; next to control rod
42		42	outer core, ring 5
57		57	outer core, ring 6
61		61	outer core, ring 6; corner
64		64	outer core, ring 6; next to peripheral control
82		82	loop SP6, ring 6

*See Fig. 1.

TABLE III. Isotope Chains Used

2DB Chain:

(n,f) reactions	(n,γ) reactions
$^{235}U \rightarrow$ FISHP	$^{238}U \rightarrow {}^{239}Pu$
$^{238}U \rightarrow$ FISHP	$^{239}Pu \rightarrow {}^{240}Pu$
$^{239}Pu \rightarrow$ FISHP	$^{240}Pu \rightarrow {}^{241}Pu$
$^{240}Pu \rightarrow$ FISHP	$^{241}Pu \rightarrow {}^{242}Pu$
$^{241}Pu \rightarrow$ FISHP	
$^{242}Pu \rightarrow$ FISHP	

REBUS-2 Chain:

Same as 2DB chain above plus,

(n,γ) reactions

FISHP $\rightarrow$ DUMP
$^{235}U \rightarrow$ DUMP
$^{242}Pu \rightarrow$ DUMP

REBUS-2 Extended Chain:

(n,f) reactions		Yield fraction
^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu $\rightarrow$	^{135}Xe	0.0715
	^{149}Sm	0.0130
	P9FP1	0.0134
	P9FP2	0.4010
	P9FP3	1.5011
		2.0000

(n,γ) reactions
$^{238}U \rightarrow {}^{239}Pu$
$^{239}Pu \rightarrow {}^{240}Pu$
$^{240}Pu \rightarrow {}^{241}Pu$
$^{241}Pu \rightarrow {}^{242}Pu$
$^{135}Xe \rightarrow$ DUMP
$^{149}Sm \rightarrow$ DUMP
P9FP1 $\rightarrow$ DUMP
P9FP2 $\rightarrow$ DUMP
P9FP3 $\rightarrow$ DUMP
$^{235}U \rightarrow$ DUMP
$^{242}Pu \rightarrow$ DUMP

(n,2n) reactions	(n,α) reactions
$^{242}Pu \rightarrow {}^{241}Pu$	$^{149}Sm \rightarrow$ DUMP
$^{241}Pu \rightarrow {}^{240}Pu$	
$^{240}Pu \rightarrow {}^{239}Pu$	
$^{239}Pu \rightarrow$ DUMP	**(n,p) reactions**
$^{235}U \rightarrow$ DUMP	$^{239}Pu \rightarrow$ DUMP
$^{238}U \rightarrow$ DUMP	

94.262 days) another explicit neutronics solution was performed rather than renormalization. However two different methods were used in performing the burnup from subinterval to subinterval. If we denote the end point of the k-*th* subinterval as time point t = k then there are a total of 11 time points at which the atom density are computed, namely, BØC or t = 0, t = 1 through t = 9, the endpoints of subinterval 1 through 9, and finally EØC or t = 10. Letting $A^k_{M,R}$ be the burn matrix for material M in region R then the equation governing the change in atom densities is

$$\frac{d}{dt}\vec{N}_{M,R}(t) = A^k_{M,R}\left[\phi_R(t)\right]\vec{N}_{M,R}(t) , \qquad t_{k-1} \le t \le t_k , \tag{1}$$

where $\vec{N}_{M,R}$ is the atom density vector for material M in region R and $\phi_R(t)$ is the flux in region R at time t. Defining the transmutation matrix $B^k_{M,R}$ as

$$B^k_{M,R} = \exp\left[A^k_{M,R} * T\right] , \tag{2}$$

where T is the length of a subinterval, i.e., 94.262 days/10, the atom densities at $t = t_k$ are then found from those at $t = t_{k-1}$ by the expression

$$\vec{N}_{M,R}\left(t_k\right) = B^k_{M,R} * \vec{N}_{M,R}\left(t_{k-1}\right) . \tag{3}$$

Two forms of the burn matrix are considered in the solution of Eq. (1), namely

$$A^k_{M,R}\left[\phi_R(t)\right] = A^{k-1}_{M,R}\left[\phi_R\left(t_{k-1}\right)\right] \tag{4}$$

or

$$= \frac{1}{2}\left\{A^k_{M,R}\left[\phi_R\left(t_k\right)\right] + A^{k-1}_{M,R}\left[\phi_R\left(t_{k-1}\right)\right]\right\} . \tag{5}$$

Equation (4) represents the solution method used in the 2DB code, namely, the burn matrix at time point $t = k - 1$ is used in performing the burnup to achieve the atom densities at the next time point, $t = k$. Equation (5), on the other hand, is the normal method of operation for the REBUS-2 code. The burn matrix for time point $k - 1$ is first used to predict the atom densities at $t = k$. These atom densities are then used to determine the fluxes at $t = k$, in this case a simple renormalization to the specified power, which are then used in constructing a burn matrix for the k time point. The arithmetic average of the $k - 1$ and k burn matrix is then used in Eq. (3) to obtain a revised set of atom densities at time point k.

The results for both methods of solution are presented here and compared with the 2DB values. To distinguish between them, the second method in which Eq. (5) is used will be referred to as the "average A matrix" method.

III. COMPARISON

Computational Results

The amount of poison in each of the six outer control rods in the 2DB run was such as to give a BØC k_{eff} of 1.011805. Hence the poison of the REBUS-2 runs was adjusted to give the same BØC k_{eff} value before the burn was even attempted. The results of the two runs, one with and one without A matrix averaging are shown in Table IV along with the 2DB values. As might be expected the REBUS-2 run without burn matrix averaging most closely duplicates the 2DB figures. The principal difference between the two codes is the amount of poison required to achieve a BØC k_{eff} of 1.0118. The REBUS-2 code requires 2% less poison. If the 2DB poison eigenvalue is used in the REBUS-2 calculations, a BØC k_{eff} of 1.011412 is obtained, which differs from the 2DB value by 0.04%. The small eigenvalue difference (approximately 12 cents) using the same BØC atom densities and cross sections provides an excellent cross check of the neutronics of both REBUS-2 and 2DB. The data of Table IV indicate a slope of $\Delta k_{eff}/\Delta x\big|_{x=0.285} = -0.070$ for the REBUS-2 run with no averaging of the A matrix. The 2DB output data, on the other hand, yields a figure of $\Delta k_{eff}/\Delta x = -0.091$.

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III. COMPARISON

Computational Results

The amount of poison in each of the six outer control rods in the 2DB run was such as to give a BOC k_{eff} of 1.011805. Hence the poison of the REBUS-2 runs was adjusted to give the same BOC k_{eff} value before the burn was even attempted. The results of the two runs, one with and one without A matrix averaging are shown in Table IV along with the 2DB values. As might be expected the REBUS-2 run without burn matrix averaging most closely duplicates the 2DB figures. The principal difference between the two codes is the amount of poison required to achieve a BOC k_{eff} of 1.0118. The REBUS-2 code requires 2% less poison. If the 2DB poison eigenvalue is used in the REBUS-2 calculations, a BOC k_{eff} of 1.011472 is obtained, which differs from the 2DB value by 0.04%. The small eigenvalue difference (approximately 12 cents) using the same BOC atom densities and cross sections provides an excellent cross check of the neutronics of both REBUS-2 and 2DB. The data of Table IV indicate a slope of $\Delta k_{eff}/\Delta X\big|_{X=0.285} = -0.070$ for the REBUS-2 run with no averaging of the A matrix. The 2DB output data, on the other hand, yields a figure of $\Delta k_{eff}/\Delta X = -0.081$.

TABLE IV. FTR Comparison, Reproduction Constant

	2DB	REBUS-2	Δ, %[a]	REBUS-2, averaged A matrix	Δ, %[a]
BØC k_{eff}	1.011805	1.011806	0.0000	1.011806	0.0000
EØC k_{eff}	0.984075	0.984053	-0.0022	0.984000	-0.0076
Δk_{eff}	0.027730	0.027763	0.0829	0.027806	0.2741
$\Delta\rho$	.027850	0.027874	0.0862	0.027928	0.2801
Control Eigenvalue	0.28491	0.27930	-1.9690	0.27930	-1.9690
BØC ρ	0.0116672	.0116682	0.0086	0.0116682	0.0086
EØC ρ	-0.0161827	-.0162054	0.1403	-0.0162601	0.4783

[a]Relative to 2DB.

Table V lists the burnup computed for each of the 14 comparison zones. Though the REBUS-2 figures agree to within several percent of the 2DB values, the averages show that the REBUS-2 values are uniformly high. Since the comparison figures are in terms of MWD/MT the computed values depend on the values used for the atomic weights as well as the value of Avogadro's number. For the REBUS-2 calculations it was assumed the 2DB code used a value of $0.60225 \times 10^{24}(\text{g-mole})^{-1}$. Any deviation from this figure by 2DB would directly affect the data of Table V. There are no figures available for the burnup in the test loops for the 2DB case since the code assumed there was no fissile material present.

The fraction of total power produced in each region is compared in Table VI. These fractions are the same for the REBUS-2 runs with and without A matrix averaging and show excellent agreement with the 2DB values. The trend of the data of Table VI indicates a slightly (several hundreths of a percent) greater flux in the inner core and correspondingly less in the outer rings. Note that for many regions the figures differ by only one digit in the fifth decimal place due to rounding errors and hence the percentage differences are actually less than the listed values. These differences are negligible from an engineering point of view. The power shift relative to the BØC for each of these regions are listed in Table VII and show close agreement.

Rather than comparing EØC mass inventories which, as pointed out above, are directly dependent on the values used for the atomic weights and Avogadro's number, the actual atom densities of the active isotopes, in units of atoms/b-cm, have been tabulated. The BØC and computed EØC values for each of the 14 sample regions are given in Tables VIII-XXI. Here the REBUS-2 results are in excellent agreement with the 2DB values. As noted previously the 2DB problem was by choice not set up to contain the DUMP isotope. Such masses normally have a negligible effect on fuel management studies and hence need not be explicitly accounted for in the calculations. Hence one should compare the EØC DUMP atom densities of the REBUS-2 run with the number of atoms/cc which have been dropped from the calculation at EØC in the 2DB run, i.e., the difference between BØC and EØC total atom densities. Comparison of these figures in Tables VIII-XX show the same excellent agreement as the other isotopes.

Table V lists the burnup computed for each of the 14 comparison zones. Though the REBUS-2 figures agree to within several percent of the 2DB values, the averages show that the REBUS-2 values are uniformly high. Since the comparison figures are in terms of MWD/MT the computed values depend on the values used for the atomic weights as well as the value of Avogadro's number. For the REBUS-2 calculations it was assumed the 2DB code used a value of 0.60225×10^{24} (g-mole)$^{-1}$. Any deviation from this figure by 2DB would directly affect the data of Table V. There are no figures available for the burnup in the test loops for the 2DB case since the code assumed there was no fissile material present.

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Rather than comparing EOC mass inventories which, as pointed out above, are directly dependent on the values used for the atomic weights and Avogadro's number, the actual atom densities of the active isotopes, in units of atoms/b-cm, have been tabulated. The BOC and computed EOC values for each of the 14 sample regions are given in Tables VIII-XXI. Here the REBUS-2 results are in excellent agreement with the 2DB values. As noted previously the 2DB problem was by choice not set up to contain the DUMP isotope. Such masses normally have a negligible effect on fuel management studies and hence need not be explicitly accounted for in the calculations. Hence one should compare the EOC DUMP atom densities of the REBUS-2 run with the number of atoms/cc which have been dropped from the calculation at EOC in the 2DB run, i.e., the difference between BOC and EOC total atom densities. Comparison of these figures in Tables VIII-[illegible] excellent agreement as the other isotopes.

TABLE V. FTR Burnup Comparison, MWD/MT

Zone No.	W-2DB[a]	REBUS-2	Δ, %[b]	REBUS-2, averaged A matrix	Δ, %[b]
1	18861	19658	4.23	19690	4.40
3	19999	20017	0.09	20051	0.26
30	19359	19788	2.22	19820	2.38
7	18977	18986	0.05	19019	0.22
10	18585	18580	-0.03	18614	0.16
17	16840	17145	1.81	17176	2.00
20	14114	14308	1.37	14335	1.57
35	17576	17559	-0.10	17593	0.10
40	15564	16041	3.06	16074	3.28
42	15269	15460	1.25	15493	1.47
57	11456	11542	0.75	11567	0.97
61	9741	9951	2.16	9974	2.39
64	12719	12811	0.72	12838	0.94
82	--	26003	--	26060	--
Inner Core Avg.	17055	17392	1.98	17423	2.16
Outer Core Avg.	13376	13854	3.57	13882	3.78
Test Loops Avg.	--	22150	--	22190	--

[a]See text concerning value of Avogadro's Number.

[b]Relative to 2DB.

TABLE VI. FTR Power Comparison by Region, Power Fractions

	Zone No.	2DB	REBUS-2[a]	Δ, %[b]
BØC	1	0.01648	0.01649	0.06
	3	0.01752	0.01753	0.06
	30	0.01694	0.01695	0.06
	7	0.01659	0.01660	0.06
	10	0.01623	0.01624	0.06
	17	0.01467	0.01468	0.07
	20	0.01224	0.01225	0.08
	35	0.01535	0.01537	0.13
	40	0.01355	0.01355	0.0
	42	0.01328	0.01328	0.0
	57	0.00992	0.00991	-0.10
	61	0.00840	0.00837	-0.36
	64	0.01102	0.01100	-0.18
	82	0.000734	0.000736	+0.27
EØC	1	0.01628	0.01628	0.00
	3	0.01726	0.01727	0.06
	30	0.01671	0.01672	0.06
	7	0.01641	0.01641	0.0
	10	0.01609	0.01610	0.06
	17	0.01461	0.01461	0.0
	20	0.01230	0.01231	0.08
	35	0.01528	0.01529	0.07
	40	0.01356	0.01356	0.0
	42	0.01332	0.01333	0.08
	57	0.01004	0.01003	-0.10
	61	0.00857	0.00854	-0.35
	64	0.01114	0.01112	-0.18
	82	0.000716	0.000720	+.56

[a]Both with and without A matrix averaging.
[b]Relative to 2DB.

TABLE VI. FTR Power Comparison by Region, Power Fractions

Δ, %[b]	PERC0S-2[a]	2DB	Zone No.	
0.06	0.01649	0.01648	1	BOC
0.06	0.01753	0.01752	3	
0.06	0.01695	0.01694	30	
0.06	0.01660	0.01659	7	
0.06	0.01624	0.01623	10	
0.07	0.01468	0.01467	17	
0.08	0.01225	0.01224	20	
0.13	0.01537	0.01538	35	
0.0	0.01395	0.01395	40	
0.0	0.01328	0.01328	42	
-0.10	0.00991	0.00992	57	
-0.36	0.00837	0.00840	61	
-0.18	0.01100	0.01102	64	
+0.27	0.000736	0.000734	92	
0.00	0.01628	0.01628	1	EOC
0.06	0.01727	0.01726	3	
0.06	0.01672	0.01671	30	
0.0	0.01641	0.01641	7	
0.06	0.01510	0.01509	10	
0.0	0.01481	0.01481	17	
0.08	0.01231	0.01230	20	
0.07	0.01529	0.01526	35	
0.0	0.01356	0.01356	40	
0.08	0.01333	0.01332	42	
-0.10	0.01003	0.01004	57	
-0.35	0.00854	0.00857	61	
-0.18	0.01112	0.01114	64	
+.56	0.000720	0.000716	92	

[a]Both with and without A matrix averaging.
[b]Relative to 2DB.

TABLE VII. FTR Power Comparison by Region, Power Shift, % Relative to BØC

Zone No.	2DB	REBUS-2[a]
1	-1.21	-1.27
3	-1.48	-1.48
30	-1.36	-1.36
7	-1.08	-1.14
10	-0.86	-0.86
17	-0.41	-0.48
20	0.49	0.49
35	-0.46	-0.52
40	0.07	0.07
42	0.30	0.38
57	1.21	1.21
61	2.02	2.03
64	1.09	1.09
82	-2.45	-2.17

[a]Both with and without A matrix averaging.

TABLE VIII. FTR Fuel Inventory Comparison, Region 1 Atom Densities[a]

Isotope	BØC	2DB, EOC	REBUS-2, EØC	Δ[b]
^{235}U	0.00003140	0.00002773	0.00002773	0.0
^{238}U	0.00548600	0.00539502	0.00539500	-0.00000002
^{239}Pu	0.00126900	0.00120215	0.00120213	-0.00000002
^{240}Pu	0.00023590	0.00025482	0.00025482	0.0
^{241}Pu	0.00002783	0.00002856	0.00002856	0.0
^{242}Pu	0.00000378	0.00000422	0.00000422	0.0
FISHP	0.00028830	0.00042137	0.00042141	0.00000004
DUMP	--	--	0.00000834	0.00000834
Total Atoms	0.00734221	0.00733387	0.00734221	0.00000834
Difference from BØC		-0.00000834[c]	0.0	
		REBUS-2, averaged A matrix		
^{235}U			0.00002772	-0.00000001
^{238}U			0.00539482	-0.00000020
^{239}Pu			0.00120201	-0.00000014
^{240}Pu			0.00025486	0.00000004
^{241}Pu			0.00002856	0.0
^{242}Pu			0.00000422	0.0
FISHP			0.00042166	0.00000029
DUMP			0.00000836	0.00000836
Total Atoms			0.00734221	0.00000834
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculation whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE IX. FTR Fuel Inventory Comparison, Region 3 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ^b
^{235}U	0.00004000	0.00003549	0.00003549	0.0
^{238}U	0.00566860	0.00557792	0.00557789	-0.00000003
^{239}Pu	0.00142020	0.00134179	0.00134176	-0.00000003
^{240}Pu	0.00019200	0.00021499	0.00021500	0.00000001
^{241}Pu	0.00002740	0.00002742	0.00002742	0.0
^{242}Pu	0.00000290	0.00000334	0.00000334	0.0
FISHP	0.0	0.00014761	0.00014767	0.00000006
DUMP	--	--	0.00000255	0.00000255
Total Atoms	0.00735110	0.00734856	0.00735112	0.00000256
Difference from BØC		-0.00000254[c]	0.00000002	
		REBUS-2, averaged A matrix		
^{235}U			0.00003548	-0.00000001
^{238}U			0.00557771	-0.00000021
^{239}Pu			0.00134161	-0.00000018
^{240}Pu			0.00021504	-0.00000005
^{241}Pu			0.00002742	0.0
^{242}Pu			0.00000334	0.0
FISHP			0.00014795	0.00000034
DUMP			0.00000255	0.00000255
Total Atoms			0.00735110	0.00000254
Difference from BØC			0.00000000	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculation whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE X. FTR Fuel Inventory Comparison, Region 30 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ^b
^{235}U	0.00003546	0.00003142	0.00003142	0.0
^{238}U	0.00557700	0.00548681	0.00548677	-0.00000004
^{239}Pu	0.00134100	0.00126883	0.00126880	-0.00000003
^{240}Pu	0.00021470	0.00023502	0.00023503	0.00000001
^{241}Pu	0.00002738	0.00002774	0.00002774	0.0
^{242}Pu	0.00000334	0.00000377	0.00000377	0.0
FISHP	0.00014990	0.00028980	0.00028985	0.00000005
DUMP	--	--	0.00000540	0.00000540
Total Atoms	0.00734878	0.00134339	0.00734878	0.00000539
Difference from BØC		-0.00000539[c]	0.0	
			REBUS-2, averaged A matrix	
^{235}U			0.00003142	0.0
^{238}U			0.00548660	-0.00000021
^{239}Pu			0.00126867	-0.00000016
^{240}Pu			0.00023506	0.00000004
^{241}Pu			0.00002774	0.0
^{242}Pu			0.00000377	0.0
FISHP			0.00029011	0.00000031
DUMP			0.00000541	0.00000541
Total Atoms			0.00734878	0.00000539
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XI. FTR Fuel Inventory Comparison, Region 7 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ[b]
^{235}U	0.00004000	0.00003571	0.00003571	0.0
^{238}U	0.00566860	0.00558291	0.00558286	-0.00000005
^{239}Pu	0.00142020	0.00134543	0.00134539	-0.00000004
^{240}Pu	0.00019200	0.00021390	0.00021391	0.00000001
^{241}Pu	0.00002740	0.00002744	0.00002744	0.0
^{242}Pu	0.00000290	0.00000332	0.00000332	0.0
FISHP	0.0	0.00014006	0.00014013	0.00000007
DUMP	--	--	0.00000235	0.00000235
Total Atoms	0.00735110	0.00734877	0.00735111	0.00000234
Difference from BØC		-0.00000233[c]	0.00000001	
		REBUS-2, averaged A matrix		
^{235}U			0.00003570	-0.00000001
^{238}U			0.00558269	-0.00000022
^{239}Pu			0.00134525	-0.00000018
^{240}Pu			0.00021395	0.00000005
^{241}Pu			0.00002744	0.0
^{242}Pu			0.00000332	0.0
FISHP			0.00014040	0.00000034
DUMP			0.00000235	0.00000235
Total Atoms			0.00735110	0.00000233
Difference from BØC			0.0	

[a] In atom/b-cm.

[b] REBUS-2 relative to 2DB

[c] The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XII. FTR Fuel Inventory Comparison, Region 10 Atom Densities[a]

Isotope	BOC	2DB, EOC	REBUS-2, EOC	Δ[b]
^{235}U	0.00004000	0.00003582	0.00003582	0.0
^{238}U	0.00566860	0.00558500	0.00558496	-0.00000004
^{239}Pu	0.00142020	0.00134721	0.00134718	-0.00000003
^{240}Pu	0.00019200	0.00021302	0.00021303	0.00000001
^{241}Pu	0.00002740	0.00002739	0.00002739	0.0
^{242}Pu	0.00000290	0.00000330	0.00000330	0.0
FISHP	0.0	0.00013712	0.00013718	0.00000006
DUMP	--	--	0.00000224	0.00000224
Total Atoms	0.00735110	0.00734886	0.00735110	0.00000224
Difference from BOC		-0.00000224[c]	0.0	
		REBUS-2, averaged A matrix		
^{235}U			0.00003582	0.0
^{238}U			0.00558480	-0.00000020
^{239}Pu			0.00134704	-0.00000017
^{240}Pu			0.00021307	0.00000005
^{241}Pu			0.00002739	0.0
^{242}Pu			0.00000330	0.0
FISHP			0.00013744	0.00000032
DUMP			0.00000224	0.00000224
Total Atoms			0.00735110	0.00000224
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XIII. FTR Fuel Inventory Comparison, Region 17 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ[b]
^{235}U	0.00003612	0.00003260	0.00003260	0.0
^{238}U	0.00559100	0.00551406	0.00551401	-0.00000005
^{239}Pu	0.00135100	0.00128761	0.00128756	-0.00000005
^{240}Pu	0.00021080	0.00022790	0.00022792	0.00000002
^{241}Pu	0.00002730	0.00002748	0.00002748	0.0
^{242}Pu	0.00000327	0.00000362	0.00000362	0.0
FISHP	0.00012970	0.00025186	0.00025195	0.00000009
DUMP	--	--	0.00000404	0.00000404
Total Atoms	0.00734919	0.00734513	0.00734918	0.00000405
Difference from BØC		-0.00000406	-0.00000001[c]	
		REBUS-2, averaged A matrix		
^{235}U			0.00003260	0.0
^{238}U			0.00551386	-0.00000020
^{239}Pu			0.00128744	-0.00000017
^{240}Pu			0.00022795	0.00000005
^{241}Pu			0.00002748	0.0
^{242}Pu			0.00000362	0.0
FISHP			0.00025218	0.00000032
DUMP			0.00000405	0.00000405
Total Atoms			0.00734918	0.00000405
Difference from BØC			-0.00000001	

[a] In atom/b-cm.

[b] REBUS-2 relative to 2DB

[c] The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XIV. FTR Fuel Inventory Comparison, Region 20 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ^b
^{235}U	0.00003669	0.00003360	0.00003360	0.0
^{238}U	0.00560300	0.00553715	0.00553709	-0.00000006
^{239}Pu	0.00136400	0.00131047	0.00131041	-0.00000006
^{240}Pu	0.00020920	0.00022542	0.00022544	0.00000002
^{241}Pu	0.00002740	0.00002763	0.00002763	0.0
^{242}Pu	0.00000322	0.00000354	0.00000354	0.0
FISHP	0.00010630	0.00020890	0.00020899	0.00000009
DUMP	--	--	0.00000310	0.00000310
Total Atoms	0.00734981	0.00734671	0.00734980	0.00000309
Difference from BOC		0.00000310[c]	-0.00000001	
			REBUS-2 averaged A matrix	
^{235}U			0.00003359	-0.00000001
^{238}U			0.00553696	-0.00000019
^{239}Pu			0.00131031	-0.00000016
^{240}Pu			0.00022547	0.00000005
^{241}Pu			0.00002763	0.0
^{242}Pu			0.00000355	0.00000001
FISHP			0.00020918	0.00000028
DUMP			0.00000311	0.00000311
Total Atoms			0.00734980	0.00000309
Difference from BØC			-0.00000001	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XV. FTR Fuel Inventory Comparison, Region 35 Atom Densities[a]

Isotope	BOC	2DB, EOC	REBUS-2, EOC	Δ[b]
^{235}U	0.00003750	0.00003448	0.00003448	0.0
^{238}U	0.00531930	0.00525857	0.00525852	-0.00000005
^{239}Pu	0.00173660	0.00165058	0.00165051	-0.00000007
^{240}Pu	0.00023480	0.00025270	0.00025272	0.00000002
^{241}Pu	0.00003350	0.00003330	0.00003331	0.00000001
^{242}Pu	0.00000350	0.00000386	0.00000386	0.0
FISHP	0.0	0.00013014	0.00013025	0.00000011
DUMP	--	--	0.00000157	0.00000157
Total Atoms	0.00736520	0.00736363	0.00736522	0.00000159
Difference from BØC		0.00000157[c]	0.00000002	
		REBUS-2 averaged A matrix		
^{235}U			0.00003447	-0.00000001
^{238}U			0.00525840	-0.00000017
^{239}Pu			0.00165034	-0.00000024
^{240}Pu			0.00025275	0.00000005
^{241}Pu			0.00003331	0.00000001
^{242}Pu			0.00000386	0.0
FISHP			0.00013050	0.00000036
DUMP			0.00000157	0.00000157
Total Atoms			0.00736520	0.00000157
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XVI. FTR Fuel Inventory Comparison, Region 40 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EOC	Δ[b]
^{235}U	0.00003188	0.00002938	0.00002938	0.0
^{238}U	0.00520300	0.00514532	0.00514533	0.00000001
^{239}Pu	0.00157900	0.00150715	0.00150716	0.00000001
^{240}Pu	0.00027000	0.00028499	0.00028498	-0.00000001
^{241}Pu	0.00003358	0.00003384	0.00003384	0.0
^{242}Pu	0.00000421	0.00000455	0.00000455	0.0
FISHP	0.00023850	0.00035043	0.00035039	-0.00000004
DUMP	--	--	0.00000453	0.00000453
Total Atoms	0.00736017	0.00735566	0.00736016	0.00000450
Difference from BØC		0.00000451[c]	-0.00000001	
		REBUS-2, averaged A matrix		
^{235}U			0.00002937	-0.00000001
^{238}U			0.00514522	-0.00000010
^{239}Pu			0.00150703	-0.00000012
^{240}Pu			0.00028501	0.00000002
^{241}Pu			0.00003384	0.0
^{242}Pu			0.00000455	0.0
FISHP			0.00035061	0.00000018
DUMP			0.00000454	0.00000454
Total Atoms			0.00736017	0.00000451
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XVII. FTR Fuel Inventory Comparison, Region 42 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ[b]
^{235}U	0.00003478	0.00003224	0.00003224	0.0
^{238}U	0.00526500	0.00521085	0.00521087	0.00000002
^{239}Pu	0.00165900	0.00158607	0.00158609	0.00000002
^{240}Pu	0.00025110	0.00026614	0.00026613	-0.00000001
^{241}Pu	0.00003336	0.00003340	0.00003340	0.0
^{242}Pu	0.00000382	0.00000414	0.00000414	0.0
FISHP	0.00011660	0.00022811	0.00022809	-0.00000002
DUMP	--	--	0.00000270	0.00000270
Total Atoms	0.00736366	0.00736095	0.00736366	0.00000271
Difference from BØC		0.00000271[c]	0.0	
		REBUS-2, averaged A matrix		
^{235}U			0.00003224	0.0
^{238}U			0.00521076	-0.00000009
^{239}Pu			0.00158595	-0.00000012
^{240}Pu			0.00026616	0.00000002
^{241}Pu			0.00003340	0.0
^{242}Pu			0.00000414	0.0
FISHP			0.00022830	0.00000019
DUMP			0.00000271	0.00000271
Total Atoms			0.00736366	0.00000271
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XVIII. FTR Fuel Inventory Comparison, Region 57 Atom Densities[a]

Isotope	BØC	2DB, EØC	REBUS-2, EØC	Δ[b]
^{235}U	0.00003531	0.00003324	0.00003324	0.0
^{238}U	0.00527800	0.00523650	0.00523655	0.00000005
^{239}Pu	0.00167600	0.00161819	0.00161825	0.00000006
^{240}Pu	0.00025010	0.00026450	0.00026447	-0.00000003
^{241}Pu	0.00003427	0.00003519	0.00003518	-0.00000001
^{242}Pu	0.00000378	0.00000407	0.00000407	0.0
FISHP	0.00008698	0.00017076	0.00017069	-0.00000007
DUMP	--	--	0.00000199	0.00000199
Total Atoms	0.00736444	0.00736245	0.00736444	0.00000199
Difference from BØC		-0.00000199[c]	0.0	
		REBUS-2, averaged A matrix		
^{235}U			0.00003324	0.0
^{238}U			0.00523647	0.00000003
^{239}Pu			0.00161814	0.00000005
^{240}Pu			0.00026450	0.0
^{241}Pu			0.00003518	0.00000001
^{242}Pu			0.00000407	0.0
FISHP			0.00017085	0.00000009
DUMP			0.00000199	0.00000199
Total Atoms			0.00736444	0.00000199
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XIX. FTR Fuel Inventory Comparison, Region 61 Atom Densities[a]

Isotope	BOC	2DB, EØC	REBUS-2, EØC	Δ[b]
^{235}U	0.00003199	0.00003028	0.00003029	0.00000001
^{238}U	0.00521100	0.00517406	0.00517422	0.00000016
^{239}Pu	0.00158500	0.00153737	0.00153757	0.00000020
^{240}Pu	0.00027410	0.00028619	0.00028613	-0.00000006
^{241}Pu	0.00003617	0.00003729	0.00003727	-0.00000002
^{242}Pu	0.00000426	0.00000454	0.00000454	0.0
FISHP	0.00021840	0.00028804	0.00028780	-0.00000024
DUMP	--	--	0.00000311	0.00000311
Total Atoms	0.00736092	0.00735777	0.00736093	0.00000316
Difference from BØC		-0.00000315[c]	0.00000001	
			REBUS-2, averaged A matrix	
^{235}U			0.00003029	0.00000001
^{238}U			0.00517415	0.00000009
^{239}Pu			0.00153748	0.00000011
^{240}Pu			0.00028615	0.00000004
^{241}Pu			0.00003727	0.00000002
^{242}Pu			0.00000454	0.0
FISHP			0.00028793	0.00000011
DUMP			0.00000312	0.00000312
Total Atoms			0.00736093	0.00000314
Difference from BØC			0.00000001	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XX. FTR Fuel Inventory Comparison, Region 64 Atom Densities[a]

Isotope	BOC	2DB, EØC	REBUS-2, EØC	Δ[b]
^{235}U	0.00003521	0.00003303	0.00003303	0.0
^{238}U	0.00527400	0.00522859	0.00522873	0.00000014
^{239}Pu	0.00167200	0.00161032	0.00161047	0.00000015
^{240}Pu	0.00024920	0.00026282	0.00026277	-0.00000005
^{241}Pu	0.00003357	0.00003379	0.00003378	-0.00000001
^{242}Pu	0.00000378	0.00000406	0.00000406	0.0
FISHP	0.00009592	0.00018901	0.00018880	-0.00000021
DUMP	--	--	0.00000204	0.00000204
Total Atoms	0.00736368	0.00736162	0.00736368	0.00000206
Difference from BOC		0.00000206 [c]	.0	
		REBUS-2, averaged A matrix		
^{235}U			0.00003303	0.0
^{238}U			0.00522864	0.00000005
^{239}Pu			0.00161035	0.00000003
^{240}Pu			0.00026279	-0.00000003
^{241}Pu			0.00003378	-0.00000001
^{242}Pu			0.00000406	0.0
FISHP			0.00018898	-0.00000003
DUMP			0.00000205	0.00000205
Total Atoms			0.00736368	0.00000206
Difference from BØC			0.0	

[a]In atom/b-cm.

[b]REBUS-2 relative to 2DB

[c]The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

TABLE XXI. FTR Fuel Inventory Comparison, Region 82 Atom Densities[a]

Isotope	BOC	2DB, EØC	REBUS-2, EOC	Δ[b]
^{235}U	0.00005190	0.00004750	0.00004748	-0.00000002
^{238}U	0.00013230	0.00013086	0.00013086	0.0
^{239}Pu	0.00004580	0.00004348	0.00004348	0.0
^{240}Pu	0.00000620	0.00000688	0.00000688	0.0
^{241}Pu	0.0	0.0	0.00000018	0.00000018
^{242}Pu	0.0	0.0	0.0	0.0
FISHP	0.0	0.0	0.00000615	0.00000615
DUMP	--	--	0.00000118	0.00000118
Total Atoms	0.00023620	0.00022872[c]	0.00023621	0.00000749
Difference from BØC		0.00000748	0.00000001	
		REBUS-2, averaged A matrix		
^{235}U			0.00004747	-0.00000003
^{238}U			0.00013086	0.0
^{239}Pu			0.00004347	-0.00000001
^{240}Pu			0.00000688	0.0
^{241}Pu			0.00000018	0.00000018
^{242}Pu			0.0	0.0
FISHP			0.00000616	0.00000616
DUMP			0.00000118	0.00000118
Total Atoms			0.00023620	0.00000748
Difference from BØC			0.0	

[a] In atom/b-cm.

[b] REBUS-2 relative to 2DB

[c] The 2DB problem was deliberately set up in a manner which permitted the products of captures in ^{235}U, ^{242}Pu, and FISHP isotopes (see Fig. 1) to be dropped from the calculations whereas in the REBUS-2 problem they were collected into the DUMP "isotope". Hence this number must be compared with the REBUS-2, EØC DUMP atom density.

IV. CONCLUSIONS

The calculational procedure selected by user option for the 2DB code is very close though not identical to that of REBUS-2. In the latter the EØC flux was explicitly computed rather than a renormalization of the BØC flux as in the former. This mode of operation for 2DB is based on an engineering design experience and indeed as has been seen the 2DB computed data is in general very close to that of the REBUS-2 code. The burnup swing is 0.08% less and 2% more poison was required by 2DB to achieve the same BØC k_{eff}. For the same poison eigenvalue, the REBUS-2 code gives a BØC k_{eff} which is 0.04% smaller than the 2DB value. Burnup values in MWD/MT shows the greatest deviation from the REBUS-2 results — differences on the order of several percent with the REBUS-2 overall core averages high by about 3%. These differences may be in part attributable to differences in the value of Avogadro's number assumed in the two codes. Power fractions are in much better agreement showing deviations ranging from tenths to hundredths of a percent. The pattern of deviations indicates a slightly lesser power output in the inner core regions and slightly greater in the outer regions compared with REBUS-2 although the difference is negligibly small from an engineering standpoint. Atom densities for the 14 sample regions show slight differences in power fractions. The consistently high burnup values and the slightly greater value of Δk_{eff} indicate the REBUS-2 problem is operating at a power level which is effectively slightly higher than that of the 2DB run. Likewise, the poison eigenvalue of Table IV as well as the values of the derivative $\Delta k_{eff}/\Delta x$ mentioned previously indicate the presence of an absorber in the REBUS-2 run which is not present in the 2DB calculations. Detailed examination of the data has shown no discrepancies to which these minor variations can be attributed.

A second comparison run of REBUS-2 using its normal rigorous operating mode in which an average burn matrix is utilized for the burnup across a subinterval also showed very small atom density differences with respect to 2DB. Other quantitities were not appreciably affected, the largest change being a slightly greater burnup swing.

The overall conclusion is that the data predictions of REBUS-2 and 2DB are in excellent agreement and verify the suitability of the REBUS-2 code for FTR calculations. Differences noted are small and would not affect any design decision or operation predictions.

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